



9-7-2011

Salt of the Early Civilizations: Case Studies on China

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SALT OF THE EARLY CIVILIZATIONS:

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Abstract

After a brief survey of the importance of salt to ancient China, Egypt, and Mesopotamia, this paper examines salt production and management of the Erlitou and Erligang cultures from the Yi-Luo River basin along the Yellow River and of Zhongba in the Ganjing River valley in the Yangzi's Three Gorges region. All three case studies on Bronze Age China show that the political center of these cultures was connected to peripheral resources, physically through transportation routes that went through regional centers, and politically and socially by increased stratification and strengthened inter-elite relationships. These case studies also offer evidence that local cultures and politics had a strong voice in the development and integration of peripheral resources.

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Salt is blamed today for everything from hyperactive children to hypertensive adults.¹ So, it may come as a surprise that many scholars maintain that, without salt, human society could not have made the leap from hunting gathering to farming. A substantial supply of salt is essential for an agricultural society for four reasons. First, humans consume great quantities of salt. It is a part of a person's basic nutritional requirement.² People, however, ingest salt in a quantity far above their physiological needs.³ While hunters do not have to supplement their diet with salt, an agricultural diet by itself cannot meet this craving, whether it is nutritional, sensory, or cultural.⁴ For this reason, J. G. D. Clark linked the emergence of Neolithic agrarian communities to the rise of salt manufacturing.⁵

Second, farmers need salt for their livestock as well as themselves. Like humans, hooved animals crave salt.⁶ Because livestock cannot roam in search of salt like wild animals do, farmers must feed them salt.⁷ Third, salt is crucial for food preservation. A major advantage of an agricultural society over a hunting-gathering one is a more stable food supply.⁸ As an agrarian community moves beyond hand-to-mouth existence and its population expands, resource planning becomes increasingly important.⁹ Grains can be

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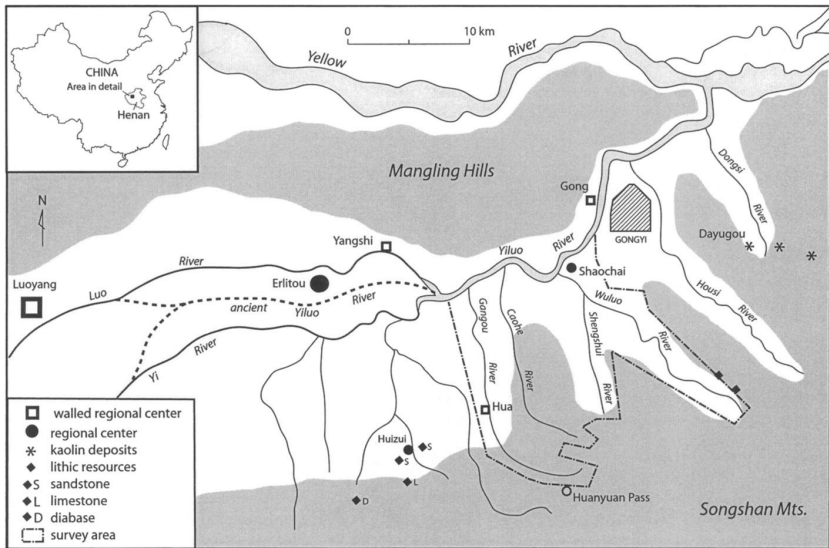
stored until the next harvest without processing.¹⁰ Stored meat and fish, by contrast, have to be preserved by drying, smoking, or salting.¹¹ Lastly, the use of salt as a preservative becomes even more valuable when an agricultural society trades with other communities.¹²

These patterns were evident in ancient China, Egypt, and Mesopotamia. Egyptian pickled fish was highly prized, both locally and by Greeks.¹³ Numerous tomb illustrations further suggest that salted mullet roe, a Near Eastern favorite, was already popular in the days of the Pharaohs.¹⁴ Moreover, salt was such a popular condiment in ancient Mesopotamia that it was mentioned in all but one or two of the recipes in a collection.¹⁵ Likewise, a Chinese saying, “Fuel, rice, oil, salt, soy sauce, vinegar, and tea,” proclaims salt as one of the seven necessities of daily life.¹⁶ A Sumerian proverb also linked salt with bread as basic foods.¹⁷ Salt was also part of the daily ration (along with barley and dried fish) given by an Akkadian temple to workers.¹⁸ Salt additionally enjoyed high medicinal and ritualistic status. Ritual offerings in the Western Zhou dynasty (1046-771 B.C.) employed salt.¹⁹ Ancient Mesopotamians prescribed it for everything from restoring potency to warding off evil.²⁰ In ancient Egypt, salt was used to treat constipation and gynecological conditions, and to speed delivery.²¹

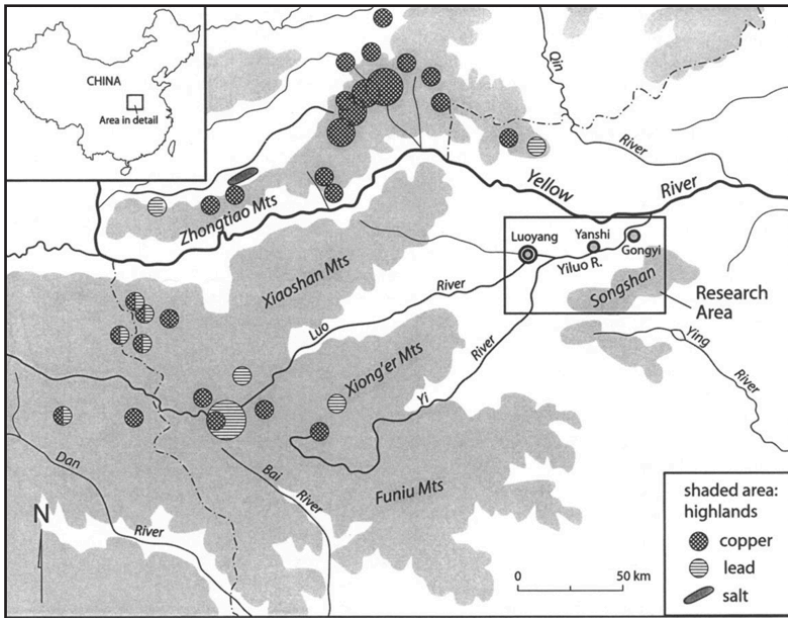
Furthermore, these civilizations supplied their livestock with salt. Like modern-day Iraqis, ancient Mesopotamians fed their animals halophytic plants from saline soil.²² Hence, the modern Egyptian practice of using halophytes from marshes as fodder for sheep and goat may have originated from ancient times.²³ Pliny mentioned that dry and bitter salt not only stimulated humans’ appetite, but that of grazing animals as well, so that they yielded more milk and better cheese.²⁴ In a scientific study, both indirect and direct salt supplements were shown to be beneficial for milk yield and fat content.²⁵ In fact, a Chinese story described how a royal concubine used salt to entice the ox that pulled the king’s cart to take him to her door.²⁶ If a pampered member of the ruling elite knew enough about livestock’s fondness for salt to use it to her own advantage, ancient Chinese farmers had to be even more keenly aware of the necessity of salt for animal domestication.

Agricultural communities in the early Bronze Age preserved fish because, with the advent of fishing nets, many more fish were caught than could be quickly consumed.²⁷ Similarly, they also preserved seasonally available animals for year-round consumption.²⁸ Even fish and meat exchanged within the community for other goods required temporary storage. After production became specialized, the ruling elite (such as the Mesopotamian

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Map 1: Settlement Locations in the Yi-Luo River Basin. From Liu et al. (2002-2004).



Map 2: Location of Key Resources near Yi-Luo River Basin. From Liu et al. (2002-2004).

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temple community) assumed responsibility for collection and redistribution of grains, fish, meat, and craft.²⁹ Fish they held for exchange had to be preserved because, while animals could be slaughtered right before they were eaten, fresh-caught fish immediately began to spoil in the Mesopotamian heat.³⁰ Herodotus reported that Egyptians ate without cooking fish, quails, ducks, and small birds that were salted, which they certainly would not have done if they did not put tremendous faith in the preservative powers of salt.³¹ Salted meat became a household item in China as early as the Warring States period (475-221 B.C.) in the late Bronze Age.³²

Ancient Egyptians and Mesopotamians also used salt to prepare exports.³³ Diodorus described large-scale fish salting in ancient Egypt, some of the products of which were then exported.³⁴ Furthermore, Herodotus mentioned salt factories in Pelusium that preserved fish for export.³⁵ King Rameses XII's use of salted fish in the apocryphal account, *The Story of Wenamun*, to pay for Lebanese cedar further shows the important role of salted fish in maintaining a trade balance.³⁶ In addition to preserving fish, ancient Mesopotamians might have used salt to preserve animal hides for tanning.³⁷ Mesopotamians and Egyptians also used salt to glaze pottery, another important export.³⁸ While Mesopotamia did not appear to export salt as a commodity, ancient Egyptians traded salt packaged as lumps or bricks.³⁹

Not surprisingly, these three ancient civilizations sat on plentiful supplies of salt. Home to salt domes rarely seen in other parts of the world, Mesopotamia has an abundance of rock salt, river salt and inland salines.⁴⁰ Egypt likewise has so much salt that Herodotus remarked, with typical enthusiasm, that the pyramids were injured by the salt oozing from the soil.⁴¹ China is no different. Yet, their demand for salt was so high that these civilizations, despite their vast supply, still had to import salt. As far back as the early Ubaid Period, nomads traded salt to Mesopotamian villagers, a practice that persisted well into the Ottoman Empire.⁴² The Chinese similarly imported salt from the Ordos in Inner Mongolia during the late 19th and early 20th centuries.⁴³

This paper will examine salt production and management in the emergence of Chinese civilization during the early Bronze Age. Archaeological discoveries made from the 1980s onward offer strong evidence that, while early Chinese states might have originated around (and radiated from) the plains of the Yellow River, many other regional cultures developed independently, which interacted with and influenced the dominant cultures.⁴⁴ Moreover, local cultures and polities played a strong role in shaping the dominant cultures' presence in peripheral regions.⁴⁵ Therefore, this paper will

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examine salt production and management both in the purported center of ancient Chinese civilization, the basin of the Yi-Luo River along the Yellow River (Map 1) in Henan, and on its fringe, the Ganjing River valley in the Three Gorges region of the Yangzi in Sichuan, site of the archaeological dig of Zhongba (Map 4).⁴⁶

Located to the south of the ancient course of the Yi-Luo River, Erlitou was the urban center of the Erlitou culture (1900-1500 B.C.), considered by many to be the semi-mythical Xia, the first Chinese hereditary dynasty (Map 1).⁴⁷ Notwithstanding China's overall rich salt supply, Erlitou's salt source was about 200 kilometers to the northwest, behind the Zhongtiao Mountains (Map 2).⁴⁸ It would be inconceivable for any ancient civilization to establish its urban center 200 kilometers away from its source of food. With salt and soy sauce as essential to the Chinese as rice, why did the Erlitou culture concentrate its population so far away from their salt supply?⁴⁹

In fact, the same geographic dislocation existed in Mesopotamia, although the ready availability of river salt probably ameliorated the situation there.⁵⁰ The Mesopotamian populace had a similarly enormous appetite for salt; Potts estimates that a staggering salt production was required to meet their intake.⁵¹ Yet if we superimposed ancient Sumerian sites over the map of late 19th century Mesopotamian salt works, we would see that, while Eridu, Ur, Uruk, Lagash, Nippur, and Kish all had access to salt, their inhabitants still would have to travel a considerable distance to obtain it.⁵²

Moreover, most other important resources such as timber, stone, clay, metal, and charcoal were located just as far away from Erlitou as salt was (Maps 1 and 2).⁵³ Erlitou's distance from crucial resources highlights the overriding strategic desirability of the Yi-Luo basin. Not only can its fertile land sustain an urban population, it is also simultaneously protected by mountain ranges and connected by rivers.⁵⁴ The Erlitou culture therefore could establish a city that was defensible without walls and at the same time easily accessible.⁵⁵ Not coincidentally, "at least ten dynasties established their capitals" in or around the Yi-Luo basin, including at nearly Luoyang.⁵⁶

Erlitou's distance from crucial resources also demonstrates its organizational and political capability. Erlitou gained control of outlying resources by sending colonists who quickly set up small and unfortified outposts near these resources.⁵⁷ These local outposts were then connected to the urban center through regional centers conveniently located along river routes. For instance, Erlitou's salt supply was the saline lake in Hedong.⁵⁸ (To be consistent with the usage in works cited, this paper will refer to the

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lake by its historical name, Xiechi, instead of its current one, the Yuncheng Salt Lake.)⁵⁹ Dongxiafeng, a local outpost about 30 kilometers north of the lake, secured this salt.⁶⁰ The collected salt traveled on the Qinglong River to Dongxiafeng, across the Zhongtiao Mountains, and down the Boqing River to the regional center of Nanguan.⁶¹ Situated at the conflux of the Boqing River and the Yellow River, Nanguan assembled Xiechi salt and copper from the Zhongtiao Mountains before transporting them to the Yi-Luo basin.⁶²

Erlitou maintained political control over its outlying resources by retaining the loyalty of its regional and local elites and commoners. The tributary system rewarded and legitimized the regional and local elites. Raw material procured at local outposts was transported by the regional center to the urban center as tribute. As a reward, the urban ruling class gave prestige goods such as bronze ritual vessels to the regional elite, who in turn rewarded the local elite by redistributing some of these goods.⁶³ Moreover by sending rations to the many laborers who lived at the local outposts, urban officials kept their regional satellites loyal.⁶⁴ So, an internal exchange of resources for rations can be outlined as well: in return for raw material sent by the regional center from a local outpost, the urban ruling class sent grain to the regional center, which in turn transported it to the local outpost to pay rations to the laborers. As a last resort, of course, Erlitou could threaten military action against the local outposts.⁶⁵

Crucial to the extraction of Xiechi salt was the powerful “southern salt wind” that swirled around the lake every summer and fall.⁶⁶ Historically, Xiechi salt was harvested whenever the wind came to finish the crystallization process begun by solar evaporation.⁶⁷ (The ancient Near East also relied on natural evaporation to extract saline and sea salt.⁶⁸) The precise preparation for the harvest, however, was unsettled until the standard was set in the Tang dynasty (618-907 A.D.) by modeling the process after rice cultivation.⁶⁹ At the start of the second lunar month, land adjacent to the lake was divided into plots and from the fourth month onward, these “paddies” were “irrigated” with lake water, which was diverted into successive plots as the sun evaporated it. When the “southern salt wind” arrived (around the eighth month) to crystallize the salt in the final plots, it would be harvested within days.⁷⁰

Although there is no known record of Erlitou preparing for a salt harvest, the explosion in the extent, density, and size of Erlitou settlements indicates a large demand for salt.⁷¹ It is difficult, then, to believe that the Erlitou culture would have exploited Xiechi salt haphazardly. Brown observes that salt production techniques stayed about the same across time and place.⁷² This

is supported by Pliny's description of salt extraction by evaporation pools employed in three saline lakes in Italy (Tarentum, Cocianus, and Gela) and three in Turkey (Phrygia, Cappadocia, and Aspendus).⁷³ His description – solar evaporation of saline lake water in small, knee-deep pools – is extremely similar to the Tang method.⁷⁴ If the Romans discovered the same method 700 years ahead of the Tang dynasty, Erlitou could conceivably have followed some of the Tang procedures.⁷⁵

The Tang method was a large-scale operation that required a sizable group of laborers to work steadily at Xiechi for six months to build evaporation plots and divert lake water.⁷⁶ Even assuming a small scale of operation, Erlitou salt extraction created a class of seasonal laborers who could perform other tasks during the off-season.⁷⁷ At the same time, Erlitou salt extraction required an even larger group of standby laborers to join the harvest whenever the “southern salt wind” materialized. Given the proximity of Xiechi to the copper mines in the Zhongtiao Mountains and the labor intensiveness of both operations, it is therefore reasonable to expect the same laborers to work at various times in the copper mines and at Xiechi (Map 2).⁷⁸ This hypothesis becomes even more plausible in light of the abandonment of Xiechi salt during the Erligang culture (1500-1300 B.C.), Erlitou's successor, after the probable exhaustion of the usable copper ore in the Zhongtiao Mountains.⁷⁹ With coastal salt available from Daxinzhuang, the dedication of a large, part-time labor force solely to harvest Xiechi salt was no longer justified.⁸⁰

Salt was most likely distributed equally throughout the entire population, for we have no evidence that the Erlitou culture controlled its population by rationing salt.⁸¹ Unlike the Mesopotamian elite who gained an economic edge from preferred access to irrigated farming, the Erlitou elite did not appear to enjoy any privilege on salt.⁸² Furthermore, the possible sharing of labor between copper mining and salt production suggests that an unspecialized labor force could increase overall production more so than a specialized one could.⁸³ Nonetheless, salt helped to increase social stratification in the Erlitou culture. Like the Mesopotamian temple elite, the central urban elite of the Erlitou culture gained power from the collection and redistribution of salt. Salt extraction created a laborer force at the periphery which was dependent on the elite for food, and the tributary system gave elite at every level (central, regional and local) disproportionate political power.⁸⁴ Erlitou's integration of peripheral outposts and the central urban center significantly increased the complexity of its political, organizational and social structures. Not only did

the salt supply encourage population growth, it increased the power of the urban center. Urban officials regulated the supply by managing the necessary labor to harvest it and storing a sufficient amount to meet the population's need.⁸⁵ Part of this power had to be shared with regional centers, which were charged with the increasingly important task of coordinating the flow of tribute to the urban center and distributing prestige goods and rations to the local outposts. This led to the appearance of four-tiered organizational hierarchies in which a regional center underneath the urban center had its own large and small villages.⁸⁶ Geographic integration was accompanied by sociopolitical integration. When the urban elite rewarded regional and local elites with prestige goods, it legitimized the peripheral elite's power, thereby increasing social stratification at many levels of the state.⁸⁷

After the Erligang culture eclipsed the Erlitou culture, it continued the Erlitou strategy of direct control and exploitation of resources by local outposts connected to the urban center through strategically located regional centers. At the same time, Erligang's expansionist policy eventually set the stage for increased trade. Strong indications exist that Erligang's rise was militaristic. Contemporaneous with the rise of the Erligang stronghold, Yanshi, six kilometers east of Erlitou, the appearance of arrowheads and broken human skeletons in the Yi-Luo basin increased drastically.⁸⁸ The proliferation of fortified Erligang centers offers further support for this hypothesis. The Erlitou culture had few walled settlements.⁸⁹ By contrast, Erligang had two urban centers, Yanshi and its capital Zhengzhou, both with double walls.⁹⁰ Even local outposts and regional centers became fortified.⁹¹ The rapid and wholesale replacement of Erlitou material culture in regional centers suggests that Erligang achieved swift and complete victory.⁹²

From the perspective of Carneiro's circumscription theory, while the Yi-Luo basin fits the description of a circumscribed agricultural environment, Erligang hardly behaved like a culture driven by population pressure to compete with its neighbors for precious land.⁹³ Even as Yanshi was contending with Erlitou, the Erligang culture appeared to have already set its sights beyond the Yi-Luo basin by founding Zhengzhou 81 kilometers east of Erlitou.⁹⁴ Equally as significant, while Erligang ceramics quickly dominated the regional centers in the Yi-Luo basin, villages in the region continued to use Erlitou-style pottery.⁹⁵ With Yanshi and Erlitou coexisting only six kilometers apart, it is easy to see how social circumscription could become a motivation.⁹⁶ The importance of resource concentration furthermore can be surmised from the fortification and expansion of local outposts.⁹⁷

Erligang's decision to place its capital Zhengzhou at the mouth of the Yi-Luo basin and delegate to Yanshi the responsibility of controlling resources to the west shows a desire to expand into new territories, tempered by a regard for consolidating its gains.⁹⁸ In fact, the new settlements established in the Lower Erligang period (1510-1425 B.C.) complemented the Erlitou sites that were secured.⁹⁹ For example, Donglongshan, a western Erlitou settlement on the Dan River and near the Luo River, occupied a strategic position where it could transport resources from the Yangzi River via the Han River and Dan River to the Yellow River.¹⁰⁰ Instead of pursuing this grand ambition, however, Erligang built Laoniupo and Huaizhenfang along the Wei River to cement Donglongshan's control of copper deposits in the Qinling Mountains.¹⁰¹

Expansion, however, became the overriding imperative in the early Upper Erligang period (1425-1300 B.C.) when Dongxiafeng and Nanguan were abandoned, probably as a result of the exhaustion of oxidized copper ore in the Zhongtiao Mountains.¹⁰² Erligang moved relentlessly south and east to secure natural resources, as if it were ruled by the Alexander the Great of ancient China.¹⁰³ To the south, Erligang expanded and fortified Panlongcheng, an underutilized Erlitou outpost with ready access to the richest copper and tin deposits in China that are furthermore located conveniently along the Yangzi.¹⁰⁴ The dream of connecting the Yangzi and the Yellow river was finally realized, with Panlongcheng collecting copper from Tongling in Jiangxi and various sites in the Daye region for transport to Zhengzhou through the tributaries of the Yangzi and the Huai River.¹⁰⁵ To the east, Erligang established a major colony of over 20 settlements around Daxinzhuang, near Jinan in Shandong, a significant benefit of which was access to sea salt from the Bohai Bay of the Yellow Sea.¹⁰⁶

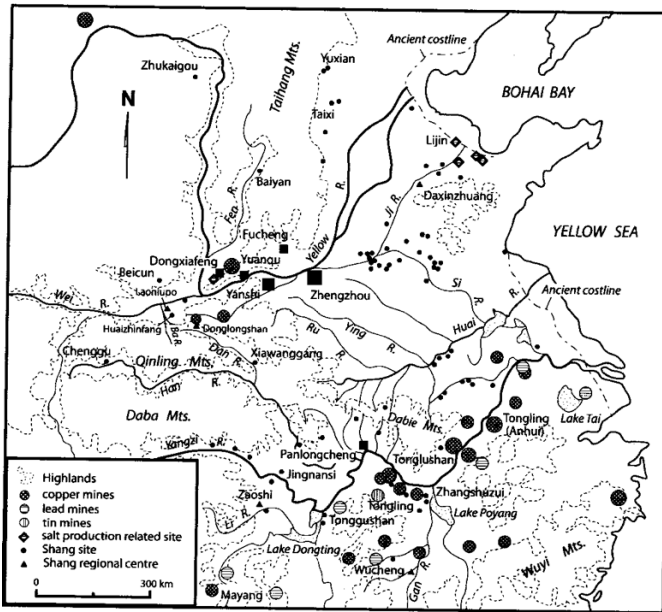
The earliest archaeological evidence at the major coastal salt production site, Lijin, yields no clue of the time that Erligang began to exploit sea salt because it was dated after the Erligang periods.¹⁰⁷ Nevertheless, the abandonment of Xiechi salt production during the Upper Erligang period offers compelling reasons why salt extraction around Daxinzhuang should have flourished by that period. It is reasonable to assume that the transition in the salt production loci involved central planning, given the need to redeploy the labor force working at Xiechi and in the copper mines and to establish new transportation routes.¹⁰⁸ Furthermore, the primary, if not only, source of a vital resource like salt would not have been abandoned unless a replacement was available. This would be especially true when there had

been a significant increase in salt demand, as suggested by the addition of a storage area to Dongxiafeng.¹⁰⁹ Besides, copper mining was already ongoing in Tongling and the Daye region during the Upper Erligang period.¹¹⁰ Since the same arguments apply to the relocation of copper mining, placing the commencement of Daxinzhuang salt production in the Upper Erligang period would synchronize the timelines of these sister industries.

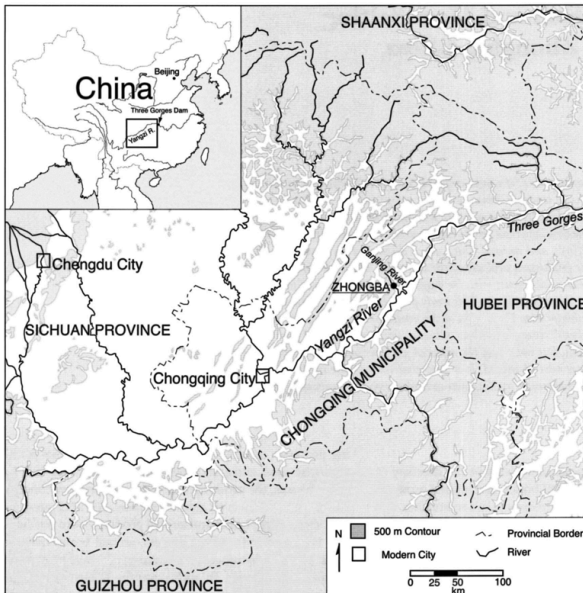
Coastal salt production offers great stability and flexibility. Pliny described salt extraction from seawater using the evaporation pool technique.¹¹¹ Unlike Xiechi salt, however, Bohai Bay salt could be crystallized by evaporation without the help of seasonal winds, so that production was more predictable. Moreover, seawater from the Bohai Bay could be boiled in the winter.¹¹² As a result, salt production was year-round and labor deployment more efficient.¹¹³ Boiling seawater to yield salt is also highly scalable.¹¹⁴ Furthermore, even though Daxinzhuang is 369 kilometers away from Zhengzhou, about 88 kilometers longer than the distance between Zhengzhou and Xiechi, it is a more convenient location.¹¹⁵ Whereas salt from Dongxiafeng had to be carried across the Zhongtiao Mountains, salt extracted from the Bohai Bay was transported from Daxinzhuang to Zhengzhou on the Ji River.¹¹⁶ So, even without the probable exhaustion of copper ore in the Zhongtiao Mountains, the Bohai Bay eventually would have supplanted Xiechi as the salt production center.

While Erligang demonstrated the same emphasis that the Erlitou culture placed on resources, transportation routes, and political and social structures, its ability to secure, control, and exploit much more widespread resources was proof of its superior organizational and political development. As a result of its southward and eastward expansion, Erligang made connections between the Yellow River and the Yangzi, as well as forged a link to the sea. Regional centers like Donglongshan, Panlongcheng, and Daxinzhuang were all situated by convenient river routes.¹¹⁷ The organizational hierarchy admittedly did not evolve beyond four tiers.¹¹⁸ Nevertheless, following Yanshi's footsteps, major regional centers became grander and acquired many more subordinate settlements. Gateway to the metal-rich Yangzi, Panlongcheng became a walled town with many surrounding settlements and centers.¹¹⁹ Daxinzhuang, which controlled the new salt source, was a preeminent colony boasting over 20 settlements.¹²⁰ The Zhengzhou ruling elite, responsible for a vast state, accumulated more power. As discussed above, the relocation of copper mining from the Zhongtiao Mountains to the hinterlands of Panlongcheng and salt production from Xiechi to the

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Map 4: (below) Location of Zhongba. From Flad (2005).



Bohai Bay showed significant administrative savvy and political muscle. To integrate the far-flung regions and localities with the political center, they in turn had to cede more power to the regional and local elite. As a result, Erligang became more socially stratified. In the center, inner walls separated the elite in Yanshi and Zhengzhou from commoners.¹²¹ At the periphery, the local elite of Daxinzhuang closely identified with Zhengzhou. For instance, a Daxinzhuang burial site painstakingly replicated every detail in the burial site of a Zhengzhou lower-level elite, down to inscribed oracle bones.¹²² Panlongcheng's elite enjoyed palatial buildings and was rewarded with many ritual vessels from Zhengzhou.¹²³ Even minor regional centers like Fucheng and Yuanqu (an offshoot of Nanguan) had palatial structures.¹²⁴ With an expanding territory, and power that was increasingly vested regionally and locally, it is easy to see how a segmented state would result once Erligang began its decline.¹²⁵ Besides the expansion into the Bohai Bay and the adoption of boiling seawater as a new form of salt production, there is no indication that salt production and management had any greater effect on the Erligang culture than the production and management of other resources.

Over the course of its sweeping expansion, Erligang encountered various indigenous cultures, and its peaceful coexistence with two of them led to its adoption of a new method to procure resources – trade rather than annexation. In the Ordos, Erligang set up a trading post at Zhukaigou to trade with tribes from Inner Mongolia.¹²⁶ To the far south, Erligang and local material cultures mingled in Wucheng, which was to become a sophisticated regional power with the subsequent decline of the Shang dynasty.¹²⁷ Wucheng was a major source of exotic goods, such as turtle shell and cowry, for which it almost certainly had to trade with local tribes further to the south.¹²⁸ This paper will now examine the development of remote Zhongba in Sichuan and its salt industry, and then its integration into dominant cultures through trading.

The Chengdu Plain of Sichuan was the birthplace of the Bronze Age culture of Sanxingdui.¹²⁹ Sichuan was known in Chinese history for its salt production.¹³⁰ Nonetheless, the first historical mention of its salt production did not occur until its forced incorporation into the dominant culture by the Qin state in 316 B.C. Even then, the record consisted of the installation of a salt and iron market official at its capital, Chengdu, in 311 B.C.¹³¹ Farther away, the Ganjing valley received no recognition for its salt production until the fourth century A.D.¹³² Major excavation there did not begin until 1997, as part of the effort to preserve archeological artifacts ahead of the completion

of the Three Gorges Dam.¹³³

The archaeological site Zhongba was located on a mound on an island in the Ganjing River.¹³⁴ The Ganjing River is a minor tributary of the Yangzi in the Three Gorges region.¹³⁵ At its conflux with the Yangzi is Shaopengzui, the archeological type-site of the Shaopengzui culture, and five kilometers upstream was Zhongba.¹³⁶ The Ganjing valley is on the edge of the Wanxian salt basin, which has endowed Sichuan with its historical bounty of salt.¹³⁷ At Zhongba and surrounding areas, groundwater that flowed through shallow salt deposits emerged as brine springs.¹³⁸ Salt was extracted in Zhongba as early as the third millennium B.C.¹³⁹ By the first millennium B.C., salt extraction had become its primary activity.¹⁴⁰ Given the modest salinity of its springs, the availability of salt was only one factor in the emergence of Zhongba as a significant salt production center.¹⁴¹ Following the pattern of Xiechi and the Bohai Bay, Zhongba also benefitted from proximity to transportation and other resources, such as sources of food and clay to make pottery used for processing brine.¹⁴² (To be consistent with the usage in works cited, this paper will refer to salt production pottery as briquetage.)

With 12-meter deep pits lined with up to 70 levels of archaeological remains from the late Neolithic era through the Bronze Age, Zhongba yielded a wealth of evidence.¹⁴³ Even more remarkably, each level was populated almost exclusively by one of three major types of briquetage that were chronologically distinct.¹⁴⁴ They were pointed-bottom vats (*jiandigang*), pointed-bottom cups (*jiandibei*), and rounded-bottom jarlets (*huandiguan*).¹⁴⁵ Found in the earliest levels (Phase I, 2500-1750 B.C.), the pointed-bottom vats, which looked like Japanese briquetage, were probably used to store brine or salt.¹⁴⁶ In the middle levels (Phase II, 1630-1210 B.C.) were pointed-bottom cups which physically resembled Mesopotamian and central European *augets*; they were probably used as molds.¹⁴⁷ The rounded-bottom jarlets in the latest levels (Phase III, 1100-200 B.C.), which looked like Mayan, Filipino, and West African briquetage as well as *kuixingqi* from the Bohai Bay, were probably used to boil brine into salt cakes.¹⁴⁸ Other architectural features also pointed to salt production. Clay-lined oval pits found in the earliest stage, for example, resembled those in African and Mexican salt production facilities.¹⁴⁹ (These pits were replaced in later levels by smaller pits and rectangular troughs.¹⁵⁰) Working surfaces found in the latest levels, which were lined with sand and clay and oriented northwest to southeast, also looked like the 'hard surfaces' discovered in Japanese salt production sites.¹⁵¹

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Each type of briquetage represents an advance in salt production technology or process. For instance, the large quantities of charcoal and numerous holes and gullies that made their debut during the rise of pointed-bottom cups suggest that, instead of relying on solar heat, brine was placed inside the cups and evaporated on a gentle fire.¹⁵² In turn, the switch to firm working surfaces was consistent with the transition to a considerably higher intensity of fire in salt production.¹⁵³ The utilization of smaller pits and rectangular troughs on a greater number of uniformly oriented working surfaces could signify a more formal layout and better-managed production process.¹⁵⁴

Moreover, this briquetage appeared within significant sociopolitical contexts. Pointed-bottom vats appeared in the late Shaopengzui culture.¹⁵⁵ Between Phases I and II, i.e., from 1750-1630 B.C., pointed-bottom cups replaced pointed-bottom vats during the emergence of the Sanxingdui culture.¹⁵⁶ Rounded-bottom jarlets, furthermore, developed under the growing influence of the neighboring Chu state. The size and shape of the jarlets became standardized during 800-350 B.C.¹⁵⁷ Immediately thereafter, 49 tombs dating from the middle to late Warring States period (358-221 B.C.) in a cemetery at nearby Yajiao displayed burial customs and goods in the style of Chu, a regional power at that time.¹⁵⁸ Archaeologists have argued from this correlation that the Ganjing valley supplied salt to Chu and possibly other states in the Yangzi region.¹⁵⁹

Since salt cakes were probably made with rounded-bottom jarlets, their standardization when Chu's presence was felt suggests that salt cakes were made in the Ganjing valley in accordance with standard Chu dimensions and, therefore, Zhongba supplied salt to Chu. Chu-style burials appeared in the Ganjing valley during Sub-phases 4-5 of Phase III (380-200 B.C.).¹⁶⁰ Export to the Chu state, then, was a likely reason why "the scale of salt production and pottery use in the latter part of Phase III was massive."¹⁶¹ It would be hasty, however, to conclude that Zhongba's involvement with the larger region began with Chu in the late Bronze Age. Evidence of Shang influence argues that Zhongba became engaged with the larger region at an earlier time. In the Shang dynasty, diviners prognosticated with cattle bones or turtle shells that were pretreated with increasing standardization.¹⁶² More remote regions began to copy these sophisticated procedures during late Shang.¹⁶³ In the Three Gorges region, Zhongba boasted the earliest and the most samples of oracle bones.¹⁶⁴ The earliest fragment dated from 2000-1750 B.C.¹⁶⁵ Another potential piece of evidence was the resemblance of

rounded-bottom jarlets to *kuixingqi* that were probably used in late Shang to boil Bohai Bay seawater.¹⁶⁶ Rounded-bottom jarlets were used in Zhongba in Phase III (1100-200 B.C.), overlapping the late Shang period (1250-771 B.C.).¹⁶⁷ Therefore, Zhongba might have borrowed the design of *kuixingqi* for its own briquetage. Zhongba's extensive consultation of Shang-style oracle bones, together with the possible connection between Zhongba and Shang briquetage, suggests that practices from the central culture filtered through to Zhongba long before the arrival of Chu in the Warring States periods.

Indeed, the sheer output of its salt production indicates that Zhongba had a substantial history of exporting salt. Salt production increased with each transition to a new type of briquetage.¹⁶⁸ Flad estimates that the pointed-bottom cups from one working area, Level 49b of Unit DT0202, would produce about 1.7 (short) tons of salt, which would supply over 2,100 people for a year, based on a daily intake of 2 grams of salt.¹⁶⁹ Even at the higher U.S.-recommended daily intake of 6 grams of salt, Level 49b alone would have supplied over 700 people for a year.¹⁷⁰ Unit DT0202 represented less than one-sixtieth of the total excavation area at Zhongba.¹⁷¹ Additionally, production with pointed-bottom cups also occurred at Shaopengzui and Wazhadi, probably after brine wells had been dug.¹⁷² So, it was unlikely that the output of Unit DT0202 would approach one-fiftieth of the total salt output of the Ganjing valley. Yet, even conservatively estimating Unit DT0202's output at one-fiftieth of total salt output and daily intake at 6 grams of salt, the pointed-bottom cups in Level 49b and equivalent levels throughout the Ganjing valley would still produce enough salt for 35,000 people to survive for a year.

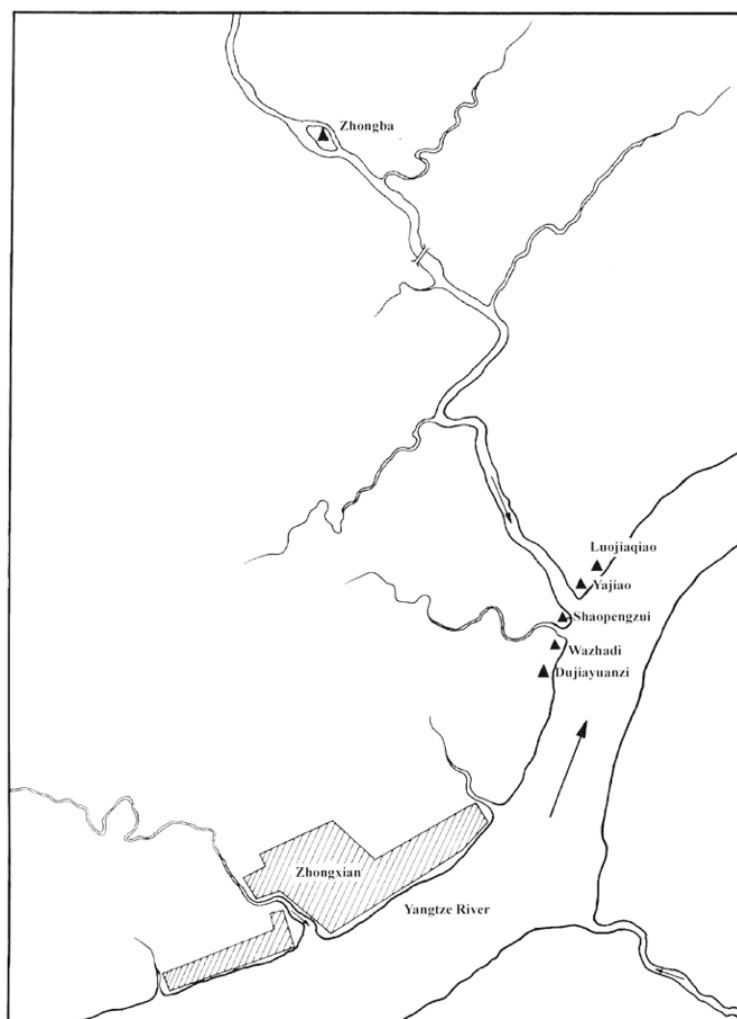
To put this number in context, consider that the levels with pointed-bottom cups ranged from 1630 to 1210 B.C. This span overlapped Erlitou III (1610-1550 B.C.), during which the Erlitou culture reached its height in urbanization.¹⁷³ Even then, the population of the urban center of Erlitou was estimated at only 18,000 to 30,000.¹⁷⁴ In other words, a frontier salt works produced up to twice the amount of salt required to sustain the population of the capital of China's "seminal" civilization. The output of rounded-bottom jarlets was even more spectacular. Flad gives a corresponding estimate of 2.5 (short) tons of salt for rounded-bottom jarlets, which, using the same conservative estimates, would supply salt to almost 51,800 people for a year.¹⁷⁵ By contrast, the settlements in the Ganjing valley were small.¹⁷⁶ They supported Zhongba's large-scale yet highly customized industry, not

vice versa. Therefore, there was no reason for Zhongba to produce salt at such a prodigious pace, and continue to increase its output, if it was not trying to meet the ever-rising demands of the populace in distant markets.¹⁷⁷

Salting fish and meat requires large quantities of salt.¹⁷⁸ If more of Zhongba's enormous salt surpluses were used locally for preserving fish and meat, then less of it would have to be attributed to external shipment of salt. In fact, there was archaeological evidence supporting a surplus production of fish and meat that was salted. In Phase III (1100-200 B.C.), the fish bones found in Zhongba surged.¹⁷⁹ There was a corresponding, but more modest, increase in mammal bones.¹⁸⁰ Among those, bones of wild game increased relative to domesticated animals.¹⁸¹ These occurred against a backdrop of increasing salt output that accelerated tremendously in Sub-phases 4-5 of Phase III.¹⁸² At the same time, the population of Zhongba probably fluctuated only slightly.¹⁸³ It is reasonable, then, to assume that there was a surplus in fish and meat and, furthermore, that the surplus was preserved with salt.¹⁸⁴ Like the salt that Zhongba produced, this surplus salted fish and meat were most likely sent externally.¹⁸⁵ Also, salted wild game would be welcome by regional elite as status symbols or an urban population as exotic food.¹⁸⁶

The surrounding regional cultures likely obtained salt, salted fish, and meat from Zhongba through trade rather than military occupation. When Erlitou and Erligang annexed local outposts and regional centers, they replaced the existing material culture with their own.¹⁸⁷ Even where Erligang formed settlements that coexisted with local culture, such as at Zhukaigou and Wucheng, Erligang material culture mingled with local material culture.¹⁸⁸ Moreover, Erlitou and Erligang operated a tight knit economic and political network maintained partly by the ruling class in the political center bestowing prestige goods such as bronze ritual vessels to regional and local elite.¹⁸⁹ In Zhongba, there was no trace of Shang or Chu cultural assemblages; the Chu-style tombs only contained imitation Chu artifacts.¹⁹⁰ Similarly, there were neither prestige goods nor signs of close center-region-local relationships. Indeed, Zhongba did not appear to have any political affiliations with lesser regional powers, such as Shu that ruled the Sichuan Basin from Chengdu.¹⁹¹ Oracle bones in Unit DT0202 display many local pretreatment variations, indicating that close political ties with the Chengdu region did not exist.¹⁹² The presence of Ba tombs in Yajiao also indicates no special ties. Not only did they not occupy the best Yajiao burial sites like the Chu-style tombs, they also had neither coffins nor respectable burial goods.¹⁹³

The discussion above forms a portrait of a peripheral salt works that



Map 5: Archeological Sites in Ganjing River Valley. From Chen (2008)

engineered a spectacular rise in production of salt and salted fish and meat in the first millennium B.C. to meet trading demands of regional powers along the Yangzi. Zhongba, therefore, eludes simple classification. Despite its limited population, it engaged in labor-intensive and large-scale salt extraction. While it resembled specialized production outposts like Dongxiafeng, Zhongba was politically independent and relied on trade to fuel its expansion. It was also socially stratified without being urban.¹⁹⁴ Perhaps it was most similar to Jericho, which rose to prominence through trade instead of agriculture and domestication.¹⁹⁵

Even though Zhongba was politically independent, it followed the same Erlitou-Erligang approach of accessing regional states by convenient transportation routes, such as Ganjing River and the Yangzi.¹⁹⁶ Similarly, Zhongba's internal organization reflected increasing social stratification and administrative complexity. As discussed above, its salt output climbed dramatically in Sub-phases 4 and 5 of Phase III.¹⁹⁷ This was achieved with little change in population.¹⁹⁸ Remarkably, it was not even clear that the total production area increased.¹⁹⁹ Instead, improvements in the manufacturing process made the production explosion possible. The standardization of round-bottomed jarlets coincided with standardization of working surfaces. Furthermore, fish and meat salting demanded a managerial presence. Salt workers would be totally unqualified to administer the crucial ancillary activities relating to food preservation, from the timing and quantity of fish and mammal procurement to the compensation for each labor specialty.²⁰⁰ Just as in Mesopotamia, Zhongba needed a managerial elite for administration and redistribution.²⁰¹

Zhongba burial and divination practices strongly indicated that Zhongba in fact had a managerial elite. Burials in the Ganjing valley displayed a surprising degree of social stratification. The overwhelming majority of graves within Zhongba proper were vertical-shaft pits in which laborers were buried without coffins; one of them was even buried in a trash pit.²⁰² By contrast, Chu-style burials in Yajiao filled the most desirable plots, and contained double coffins and ceramic and bronze burial goods.²⁰³ The deceased were probably members of the elite who benefitted from the salt-related trade with Chu or expatriate Chu merchants.²⁰⁴ In addition to Chu remnants, an extensive collection of Shang-style oracle bones was found in the salt production areas of Zhongba.²⁰⁵ Divination by oracle bones intensified during two periods of grave uncertainty over the future of salt production. The first occurred during Sub-phase 1 of Phase III (1100-700 B.C.).²⁰⁶ Rounded-bottom jarlets

had just become the new (and unproven) standard of salt production.²⁰⁷ The second period was during Sub-phase 4 of Phase III (380-310 B.C.).²⁰⁸ In addition to the threat to briquetage posed by the newly introduced iron pans, Qin's annexation of Sichuan in 316 B.C. marked this time as very turbulent for society at large.²⁰⁹ These consultations of oracle bones indicated elite presence because, whereas individuals worried about personal affairs, managerial elite worried about communal livelihood and welfare.

Each case study on Bronze Age China illustrates the supple connection between peripheral resources and the political center, through transportation routes and regional centers, as well as increasing identification of regional and local elite with an urban nucleus. The reliance on bone divination during uncertain times demonstrated that the local Zhongba elite embraced the well-defined ritual system shared by Yangzi and Yellow River cultures. This enabled Zhongba to become integrated into the larger region even in the absence of an actual political chain of command and participation in the tributary system.

Acknowledgements: The author wishes to thank Professor Rowan Flad for his helpful comments on this paper.

¹For salt's connection to ADHD, see Howard, Robinson, Smith, Ambrosini, Piek, & Oddy (in press). For reduction of sodium intake to relieve high blood pressure, see Centers for Disease Control and Prevention, *Sodium: The Facts* (Atlanta, GA: 2010).

² Flad, R.K, J. Zhu, C. Wang, P. Chen, von Falkenhausen, Z. Sun, S. Li, & F. Hole, "Archaeological and Chemical Evidence for Early Salt Production in China," *Proceedings of the National Academy of Sciences of the United States of America* 102, no. 35 (2005): 12618. 2005, p. 12618, fn. 1-4.

³ CDC, *Sodium*.

⁴ D. Potts, "On Salt and Salt Gathering in Ancient Mesopotamia," *Journal of the Economic and Social History of the Orient*, (1984): 227, 229. Cato estimated at one modius (about one peck) the annual salt intake of a Roman farm slave, whose diet was almost all vegetarian (R.J. Forbes, *Studies in Ancient Technology* (Leiden: E.J. Brill, 1964), 157).

⁵ Potts, 227.

⁶ According to Nenquin, horses need 50 grams of salt daily, while cows require nearly double that (Ibid., 250.). See also R.E. Remington, "The Social Origins of Dietary Habits," *The Scientific Monthly* 43, no. 3 (1936): 199.

⁷ H.W. Gilmore, "Cultural Diffusion via Salt," *American Anthropologist*,

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New Series 57, no. 5 (1955): 1012 and J. A. Jakle, "Salt on the Ohio Valley Frontier, 1770-1820," *Annals of the Association of American Geographers* 59 no. 4 (1969): 696.

⁸ R. C. Allen, "Agriculture and the Origins of the State in Ancient Egypt," *Economic History* 34 no. 2 (1997): 141-142.

⁹ C. Redman, "The Origins of Urban Society," in *The Rise of Civilization* (San Francisco: W. H. Freeman and Company, 1978): 232.

¹⁰ Allen, 142.

¹¹ R. Ellison, "Some Thoughts on the Diet of Mesopotamia from c. 3000-600," *Iraq* 45, no. 1 in *Papers of the 29 Recontre Assyriologique Internationale* (1982), 148.; R.K. Flad, "Evaluating Fish and Meat Salting at Prehistoric Zhongba, China," *Journal of Field Archaeology* 30, no.3 (2005):233-234.

¹² Salt was also used in Mesopotamia to manufacture pottery. See fn. 39 of this paper.

¹³ W.J. Darby, P. Ghalioungui, and L. Grivetti, *Food: the gift of Osiris* (London: Academic Press, 1977), 372.

¹⁴ *Ibid.*, 373-378; Forbes, 187.

¹⁵ J. Bottéro, "The Cuisine of Ancient Mesopotamia," *The Biblical Archaeologist* 48, no. 1 (1985). See also M. Levey, "Gypsum, Salt and Soda in Ancient Mesopotamian Chemical Technology," *Iris* 49, no. 3 (1958): 339.

¹⁶ J. E. Spencer, "Salt in China," *Geographical Review* 25, no.3 (1935): 353. Just as soy sauce was a central part of Chinese food, *garum*, a pickled fish sauce, stimulated many a Roman appetite (Pliny, as cited in Forbes, 162.). *Oenogarum*, a concoction of *garum* and wine, was also very popular (*Ibid.*, 115). The Chinese are also fond of fish sauce (Flad, "Evaluating Fish and Meat," 235.).

¹⁷ Potts, 228.

¹⁸ *Ibid.*, 265. See also Levey, M. (1958). Gypsum, Salt and Soda in Ancient Mesopotamian Chemical Technology. *Isis*, 49(3), 339.

¹⁹ L. Liu and X. Chen, *State Formation in Early China* (London: Duckworth, 2003), 47. The chronology is from R. K. Flad, "Divination and Power: A Multiregional View of the Development of Oracle Bone Divination in Early China," *Current Archaeology* 49, no. 3 (2008): 406. Salt also appeared to have been part of Assyrian sacrifices (Levey, 340).

²⁰ Potts, 229-230. Like Mesopotamian potency recipes, Roman love spells included salt to arouse passion (Forbes, *Studies*, 172). As for protection from evil, Vedic verses prescribed salt for oozing skin sores caused by flying demons (K. G. Zysk, "Religious Healing in the Veda," *Transactions of the*

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American Philosophical Society, New Series 75, no. 7 (1985): 84-86. Not only did these verses confirm that salt enjoyed a mystical reputation in ancient India, but their recognition of the absorbent property of salt and its function as a preservative against impurities also suggests that salt was a well-used commodity at that time.)

²¹ Darby, 451.

²² Potts, 250.

²³ H. M. El Shaer, "Potentiality of halophytes as animal fodders under arid conditions of Egypt," in *Cash Crop Halophytes: Recent Studies. Tasks for vegetation science*, ed. H. Lieth and M. Mochtchenko (Dordrecht, Netherlands: Kluwer, 2003), 113.

²⁴ Forbes, 161-162. Given its positive effect on appetite, salt was most likely used to fatten cattle as well.

²⁵ C. P. Chiy and C. J. C. Phillips, "The Effects of Sodium Chloride Application to Pasture, or Its Direct Supplementation, on Dairy Cow Production and Grazing Preference," *Grass and Foraging Science* 46, no. 3 (1991).

²⁶ U. A. Casal, "Salt," *Monumenta Nipponica* 14, no. 1/2 (1958): 81.

²⁷ Flad, "Evaluating Fish and Meat," 244.

²⁸ Ibid., 238. For example, fish and fowl may arrive seasonally for spawning or migration.

²⁹ Redman, 233.

³⁰ Ellison, 148. See also Levey, 339.

³¹ Forbes, 186.

³² Salted meat (including pork) was mentioned in the burial inventory recorded on bamboo slips found inside the tomb of an official (Flad, "Evaluating," 234-235.). The chronology is from Flad, "Divination," 406.

³³ Similarly, Strabo remarked that Gaul used large quantities of salt in connection with exporting salted pork to Rome (Forbes, 173).

³⁴ Darby, 369; see Lucian's quote on p. 372 for an indication of how sought after they were.

³⁵ Darby et al., 369, 372. *The Story of Wenamun* also noted that Egypt exported salted fish to Syria (Forbes, 187).

³⁶ Darby et al., 372.

³⁷ Both dry salt and brine were used in curing (Forbes, 3). Crawford, however, noted the scant archaeological evidence for tanning: only one concave knife from the Loftus hoard that could have been used for hair removal and metal points at Tello that might have stretched hide for

processing (Crawford, Crawford, H. E. W. (1973). "Mesopotamia's Invisible Exports in the Third Millennium B.C." *World Archaeology*, 5(2), 236).

³⁸ Thompson (1925) described the Assyrian technique of using salt to apply blue glaze (as cited in Levey, 340). Ancient Egyptians also used salt to manufacture glazes (Forbes, 167). Salt was also involved in the separation of gold from silver (Forbes, 167, 174; Potts, 234). Soldering and dyeing furthermore used salt (Forbes, 174).

³⁹ Forbes, 167. Also, salt from the Dead Sea was a major export of Jericho (Seddon, J. D. (1966). *The Origins of Domestication: Some Developments in the Last Five Years*.

The South African Archaeological Bulletin, 21(83), 104). An Ur III text that mentioned salt bricks from the saline of Semava near Ur suggests that salt might have been traded within Mesopotamia (Potts, 259).

⁴⁰ Forbes, 168; Potts, 235-236. See also Levey, 338.

⁴¹ Forbes, 167.

⁴² Copeland, M. A. (1974). "Concerning the Origin of a Money Economy." *American Journal of Economics and Sociology*, 33(1), 6; Potts, 1984, 254-255.

⁴³ Serruys, H. (1977). "Five Documents regarding Salt Production in Ordos." *Bulletin of the School of Oriental and African Studies, University of London*, 40(2), 344.

⁴⁴ Bagley, R. (1999). Shang Archaeology. In M. Loewe & E. L. Shaughnessy (Eds.) *The*

Cambridge History of Ancient China: From the Origins of Civilization to 221 B.C. (pp. 124-231). Cambridge: Cambridge University Press. 230-231; Lawler, A. (2009). Beyond the Yellow River: How China Became China. *Science New Series*, 325(5943); Liu, L., & Chen, X. (2006). Sociopolitical Change from Neolithic to Bronze Age China. In M. T. Stark (Ed.), *Archaeology of Asia* (pp. 149-176). Padstow, Cornwall: Blackwell Publishing. 151.

⁴⁵ Flad, personal communication, April 12, 2011.

⁴⁶ Liu, L., & Chen, X. (2006). "Sociopolitical Change from Neolithic to Bronze Age China," in M. T. Stark (Ed.), *Archaeology of Asia*, 151.

⁴⁷ *Ibid.* 163; Liu, L., Chen, X., Lee, Y. K., Wright, H., & Rosen, A. (2002-2004). "Settlement Patterns and Development of Social Complexity in the Yiluo Region, North China." *Journal of Field Archaeology*, 29(1/2), 76.

⁴⁸ Liu & Chen, "Sociopolitical Change," 167.

⁴⁹ Spencer, 353.

⁵⁰ Potts, 236. With few, if any, urban centers, ancient Egypt did not face the

same problem.

⁵¹ *Ibid.* 265-268. The dearth of hard archaeological and textual evidence, unfortunately, makes estimation a necessary evil. Potts, 255. The inherent difficulty of deciphering Sumerian and Akkadian records was also raised in Levey, 337.

⁵² Potts, 237, Map 1. Likewise for Akkadian sites, Nineveh's salt supply was 100-125 miles (approximately 161-201 kilometers) away (Potts, 243).

⁵³ Liu & Chen, *State Formation*, 35; Liu and Chen, "State Formation," 166.

⁵⁴ Liu et al., 76-77.

⁵⁵ Liu & Chen, *State Formation*, 35.

⁵⁶ Liu et al., 77.

⁵⁷ Liu & Chen, *State Formation*, 82-83. Flad, however, cautions that the evidence for an Erilitou expansion is much more circumstantial than that for Erligang (personal communication, April 12, 2011).

⁵⁸ Liu & Chen, *State Formation*, 44-45.

⁵⁹ Flad, R. K. (2007). "Rethinking the Context of Production through an Archaeological Study of Ancient Salt Production in the Sichuan Basin, China," in Z. X. Hruby & R. K. Flad (Eds.), *Rethinking Craft Specialization in Complex Societies: Archaeological Analyses of the Social Meaning of Production. Archaeological Papers of the American Anthropological Association, Number 17* (pp. 108-128). Berkeley: American Anthropological Association and the University of California Press. 113; Zheng, M., Tang, J., Liu, J. & Zhang F. (1993). "Chinese Saline Lakes." *Hydrobiologia*, 267(1-3), 23.

⁶⁰ Liu & Chen, *State Formation*, 73.

⁶¹ Liu & Chen, *State Formation*, 55, Fig. 11. Liu & Chen assumed that Erilitou followed the same transportation route used in the Qing dynasty (1644-1912 A.D.). Others have used similar approaches. For example, Potts estimated the salt production of ancient Mesopotamia from that of the Ottoman Empire.

⁶² Liu & Chen, *State Formation*, 73.

⁶³ This is a simplified version of the description in Liu & Chen, which needlessly insisted that the urban ruling elite had to redistribute a processed form of the same raw material offered as tribute (Liu & Chen, 2003, pp. 135-141). That would work for metal ore or exotic fur, but fail with subsistence goods like salt or charcoal.

⁶⁴ See discussion about labor needs in this paper. Tora, Y. (1993). *Salt Production Techniques in Ancient China: the Aobo Tu* (Hans Ulrich Vogel, Trans.),

New York: E.J. Brill.¹³, also mentioned tapping the state granaries for ration.

⁶⁵ The poor defensive value of the local outposts might have been calculated to ensure their subordination to the urban center (Liu & Chen, *State Formation*, 83).

⁶⁶ Forbes, 65; Tora,¹³; Zheng et al., 23.

⁶⁷ Liu & Chen, *State Formation*, 46. Chiang claimed that, prior to the Tang dynasty, salt crystals were dredged from Xiechi (referred to as Chiehch'ih) (Chiang, T. (1976). The Production of Salt in China, 1644-1911. *Annals of the Association of American Geographers*, 66(4), 527). However, pre-Tang evidence supported the account in Liu & Chen of evaporation and wind. A Northern Wei dynasty (386-534 A.D.) treatise, *Shuijingzhu* (*Commentary on the Book of Waterways*), described salt extraction from Xiechi by evaporation; an ancient folk rhyme, the “South Wind,” also declares that when a south wind blows, it is time to make salt in the sun (Zheng et al., 23). Furthermore, Forbes noted that, because a smelly sludge settled at the bottom of evaporation pools, salt workers had to skim the salt with flat shovels (Forbes, 165-166). Possibly, perhaps, Chiang used “dredged” when “skimmed” was meant. Chiang’s version of the Tang dynasty method also contained a possible error, i.e., that salt was harvested at least twice a year (Chiang, 527). Tora and Liu & Chen described the Tang method as an annual harvest (Tora, 13; Liu & Chen, 47).

⁶⁸ Potts, 249.

⁶⁹ Chiang, 527; Liu & Chen, *State Formation*, 47. Tora described the Song dynasty (960-1279 A.D.) practice of the Tang method.

⁷⁰ Liu & Chen, *State Formation*, 47; Tora, 13. See also Chiang, 527.

⁷¹ Liu et al., 95.

⁷² Potts, 226, fn. 2. As mentioned earlier, the ancient Near East also relied on evaporation to extract saline and sea salt (Potts, 249).

⁷³ As cited in Forbes, 158.

⁷⁴ Forbes, 158. Strabo also reported that “the Etesian winds” crystallized salt from the sea at the Tragasaeon salt-pan near Hamaxitus (as cited in Forbes, 169).

⁷⁵ According to Pliny, European salt was extracted first from quarries and then wells, with solar evaporation being the last method adopted (as cited in Forbes, 162). Even though the Erlitou culture occurred earlier in time, it started with evaporation. Still, this is a conjecture that is supported by neither archaeological evidence nor textual record.

⁷⁶ Tora, 14.

⁷⁷ Allen, 143.

⁷⁸ Liu & Chen, *State Formation*, 128-129.

⁷⁹ *Ibid.* 128-129. The chronology is from Bagley, 165, and Flad, R. K. (2008). "Divination and Power: A Multiregional View of the Development of Oracle Bone Divination in Early China." *Current Archaeology*, 49(3), 406.

⁸⁰ Liu & Chen, *State Formation*, 114. Based on evidence of an increasingly humid climate, the salt yield from Xiechi might also have dropped (*Ibid.* 129).

⁸¹ Liu & Chen, *State Formation*, 137. Of course, Erilitou laborers, like their Akkadian counterparts, might have been paid in rations that included salt.

⁸² Redman, 232.

⁸³ For the case in favor of specialization, see Fried, 1960, p. 722, and Redman, 1978, p. 233.

⁸⁴ Fried, M. (1960). "On the Evolution of Social Stratification and the State," in S. Diamond (Ed.) *Culture in History: Essays in Honor of Paul Rodin*. (pp. 713-731). New York: Columbia University Press. 721. It is interesting to note that the process of ever-downward delegation of authority, begun by the Erilitou culture, reached a point in the Song and Yuan dynasties that even salt producers were socially stratified, so that the "elite" producers assumed the role of supervisors and tax collectors (Tora, 41-43).

⁸⁵ Erilitou-Lower Erligang (1900–1425 B.C.) was one of the three periods of sharp population increase in the Gongyi survey area during early Chinese civilization (Liu et al., 95). (The same diagram appeared in Liu & Chen, *State Formation*, 32, where it was not clearly indicated that Erilitou and Lower Erligang data were combined.) The Erilitou elite gained power from salt administration in the same way that the Mesopotamian elite did from irrigated farming (Redman, 233).

⁸⁶ Liu et al., 88-90.

⁸⁷ *Ibid.* 90.

⁸⁸ Liu & Chen, *State Formation*, 86, 91-92.

⁸⁹ Bagley, 157; Liu & Chen, *State Formation*, 35.

⁹⁰ Liu & Chen, *State Formation*, 146.

⁹¹ For instance, Dongxiafeng and Nanguan were fortified during the Lower Erligang period (Liu & Chen, *State Formation*, 102).

⁹² *Ibid.* 87.

⁹³ Carneiro, R. L. (1970). "A Theory of the Origin of the State." *Science, New Series*, 169(3947), 733-738.

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⁹⁴ Bagley, 168; Liu & Chen, *State Formation*, 86.

⁹⁵ Liu et al., 92.

⁹⁶ See Map 1.

⁹⁷ Dongxiafeng and Nanguan, for example, were fortified and expanded (Liu & Chen, *State Formation*, 102-103). Fucheng, another Erlitou regional center, also became a walled settlement (Liu & Chen, *State Formation*, 100).

⁹⁸ *Ibid.* 101.

⁹⁹ The chronology is from Flad, "Divination and Power," 406.

¹⁰⁰ See Map 3. There was no evidence, however, that Erlitou exploited this potential to any significant degree (Liu & Chen, *State Formation*, 74-75).

¹⁰¹ *Ibid.* 110-112.

¹⁰² *Ibid.* 105-106. The chronology is from Flad, "Divination and Power," 406.

¹⁰³ Liu & Chen, *State Formation*, 127. Bagley described the Erligang expansion as imperial conquest (Bagley, 170). Coincidentally, Strabo mentioned that Alexander the Great brought a mining engineer and prospector, Gorgus, on his campaign (as cited in Forbes, 170 and Darby et al., 449).

¹⁰⁴ Liu & Chen, *State Formation*, 78; Flad, personal communication, April 12, 2011. Panlongcheng was secured in the Lower Erligang period, but expansion did not occur until the Upper Erligang period, when a town wall was constructed and the area increased fivefold (Liu & Chen, *State Formation*, 116).

¹⁰⁵ Liu & Chen, *State Formation*, 116-119. The most famous copper foundry in Daye, Tonglushan, probably was not established until the Yinxu period (*Ibid.* 44). The route was shown in *Ibid.* 51, Fig. 10.

¹⁰⁶ *Ibid.* 113-116.

¹⁰⁷ A number of *kuixingqi* (helmet-shaped vessels) dating from the late Shang period (also known as the Yinxu period, 1250-771 B.C.) had been found near the Bohai Bay, including at Lijin; they were probably used for boiling seawater (Liu & Chen, *State Formation*, 47-48). Flad noted the similarity between *kuixingqi* and rounded-bottom jarlets used in Zhongba salt production (which also dated from 1100 B.C., corresponding with the late Shang period) (Flad et al., "Archaeological and Chemical Evidence," 12619).

¹⁰⁸ Liu & Chen, *State Formation*, 129.

¹⁰⁹ *Ibid.* 105.

¹¹⁰ *Ibid.* 116.

¹¹¹ As cited in Forbes, 164-166. The only difference is that, prior to being

channeled into small pools, seawater was evaporated in salterns that were ten times larger (Forbes, 164).

¹¹² The technique of boiling brine to crystallize salt was employed in Zhongba by the early Bronze Age (Chen, P. (2008). "Technical changes in the salt production from the Neolithic Period to the Han Dynasty at Zhongba." In O. Weller, A. Dufraisse, & P. Pétrequin (Eds.), *Sel, eau et forêt – D'hier à aujourd'hui* (pp. 143-161). Paris: Presses universitaires de Franche-Comté. 156).

¹¹³ Liu & Chen, *State Formation*, 129. This does not preclude different sets of laborers from working during different seasons.

¹¹⁴ This scalability turned out to be a hidden bonus toward the end of the Upper Erligang period. Under the political instability at that time, the protracted and systematic process of harvesting Xiechi salt would not have been possible.

¹¹⁵ Calculated at <http://www.mapcrow.info/>. Retrieved from http://www.mapcrow.info/Distance_between_Jinan_CH_and_Zhengzhou_CH.html

¹¹⁶ Daxinzhuang offered a third connection from the Yangzi to the Yellow River, via the Huai River, Si River, and Ji River, which was little-used because there were no resources along the way. See Map 3.

¹¹⁷ Even if the Yi-Luo basin was not the hub of Chinese civilization, rivers were surely its spokes.

¹¹⁸ Liu & Chen, *State Formation*, 137-140.

¹¹⁹ *Ibid.* 117.

¹²⁰ *Ibid.* 113.

¹²¹ *Ibid.* 146.

¹²² Li, M. (2008). *Conquest, Concord, and Consumption: Becoming Shang in Eastern China*. (Doctoral dissertation). 15-16. Interestingly, Yinxu (center) and Daxinzhuang (periphery) are the only sites where inscribed oracle bones have been found (Flad, "Evaluating Fish," 413; personal communication, April 12, 2011).

¹²³ Liu & Chen, *State Formation*, 117.

¹²⁴ *Ibid.* 100, 105. The burial sites of local elite were also found in Yuanqu (Liu & Chen, *State Formation*, 105).

¹²⁵ The segmented or "segmentary" state model was described in Liu & Chen, *State Formation*, 17-18.

¹²⁶ *Ibid.* 108.

¹²⁷ *Ibid.* 119-123.

¹²⁸ *Ibid.* 123.

¹²⁹ Chen, 149.

¹³⁰ Flad, R. K., Wu, X., von Falkenhausen, L., Li, S., Sun, Z., & Chen, P. (2009). "Radiocarbon Dates and Technological Change in Salt Production at the Site of Zhongba in the Three Gorges, China." *Asian Perspectives*, 48(1), 152.

¹³¹ Flad, "Rethinking the Context," 112. For Sichuan's earlier contact with other warring states, see same, 119-120.

¹³² The first Chinese geographic reference book, *Huayangguozhi* (*Record of the States South of Mt. Hua*), written in fourth century A.D., identified salt production as the principal livelihood of the Ganjing valley, under its historical name of Linjiang County (Chen, 144; Flad et al., "Radiocarbon Dates," 151).

¹³³ Chen, 144; Flad, "Rethinking the Context," 113; Flad et al., "Radiocarbon Dates," 151.

¹³⁴ Flad, "Archaeological and Chemical Evidence," 232-233; Flad, "Rethinking the Context," 113. Past tense is used because Zhongba is now flooded by the Three Gorges Dam. It is unclear what other sites in the Ganjing valley have also been submerged.

¹³⁵ Chen, 144; Flad, "Evaluating Fish," 232; Flad, "Rethinking the Context," 113. See also Map 4.

¹³⁶ Chen, 144, 146. See also Map 5.

¹³⁷ Chen, 144; Flad et al., "Radiocarbon Dates," 152.

¹³⁸ Chen, 144; Flad, "Rethinking the Context," 113; Flad et al., "Radiocarbon Dates," 152.

¹³⁹ Flad, "Evaluating Fish," 232-233; Flad, "Rethinking the Context," 113.

¹⁴⁰ Flad et al., "Archaeological and Chemical Evidence," 12618, 12621.

¹⁴¹ The brine concentration was about 2-5 ° Baumé (Chen, 144).

¹⁴² Flad et al., "Radiocarbon Dates," 152.

¹⁴³ Flad et al., "Archaeological and Chemical Dates," 12618. After the Bronze Age, briquetage plummeted because iron pans became the standard vessel to boil brine or seawater (Flad, "Evaluating Fish," 233; Chen, 156-157).

¹⁴⁴ Flad et al., "Archaeological and Chemical Evidence," 12619. See also Flad et al., "Radiocarbon Dates," 153-154.

¹⁴⁵ *Ibid.* 154-156.

¹⁴⁶ Flad, "Evaluating Fish," 234; Flad, "Rethinking the Context," 116. See also Flad et al., "Radiocarbon Dates," 168. Flad was alone in using 2000 B.C. as the starting point (Flad et al., "Archaeological and Chemical

Evidence,” 12619). At 40 centimeters in diameter, pointed-bottom vats were the largest type (Flad et al., “Radiocarbon Dates,” 154). They might also be used for the production of salt or fish sauce (Flad et al., “Radiocarbon Dates,” 157).

¹⁴⁷ Flad, “Evaluating Fish,” 234; Flad et al., “Archaeological and Chemical Evidence,” 12619; Flad, “Rethinking the Context,” 116; Flad et al., “Radiocarbon Dates,” 155, 157. Averaging 10 and 12 centimeters in diameter and heightened, pointed-bottom cups were smaller (estimated from Chen, 150, Fig. 5).

¹⁴⁸ Flad, “Evaluating Fish,” 234; Flad et al., “Archaeological and Chemical Evidence,” 12619; Flad, “Rethinking the Context,” 116; Flad et al., “Radiocarbon Dates,” 156-157. Averaging 9 and 12 centimeters in diameter and heightened, rounded-bottom jarlets were the smallest (Chen, 153).

¹⁴⁹ Flad et al., “Archaeological and Chemical Evidence,” 12619.

¹⁵⁰ Chen, 153-154.

¹⁵¹ *Ibid.* 152-153.

¹⁵² Chen speculated that the holes anchored temporary racks that held pointed-bottom cups while they were being heated (Chen, 151).

¹⁵³ English salt works also had clay floors heated by flues (Forbes, 173). So, it is possible that the hard surface facilitated heat induction.

¹⁵⁴ Chen, 153, 157; Flad, “Rethinking the Context,” 119. See also next paragraph about the standardization of the jarlets.

¹⁵⁵ Chen, 147.

¹⁵⁶ Chen, 149.

¹⁵⁷ Flad et al., “Radiocarbon Dates,” 167. The chronology is from Flad, “Divination and Power,” 406.

¹⁵⁸ Flad, “Rethinking the Context,” 119-120. See also Chen, 157. Unlike Shaopengzui and Zhongba, Yajiao is a newer settlement from the first millennium (Flad et al., “Radiocarbon Dates,” 175). The chronology of mid-to-late Warring States period is derived from Flad, “Divination and Power,” 406.

¹⁵⁹ Chen, 157 ; Flad et al., “Radiocarbon Dates,” 176.

¹⁶⁰ Flad, “Evaluating Fish,” 234, Table 1; Flad, “Rethinking the Context,” 116, Table 7.1.

¹⁶¹ Flad, “Rethinking the Context,” 118. Reservation of the best Yajiao burial sites for Chu-style tombs also reflected Chu’s prominence in the Ganjing valley (Flad, “Rethinking the Context,” 120).

¹⁶² Flad, “Divination and Power,” 411.

¹⁶³ *Ibid.* 418.

¹⁶⁴ *Ibid.* 414, 416.

¹⁶⁵ Flad, “Rethinking the Context,” 121.

¹⁶⁶ Flad et al., “Archaeological and Chemical Evidence,” 12619. See fn. 107 of this paper for a description of *kuixingqi*.

¹⁶⁷ Flad et al., “Archaeological and Chemical Evidence,” 12619. The chronology is from Flad, “Divination and Power,” 406.

¹⁶⁸ Flad et al., “Radiocarbon Dates,” 175.

¹⁶⁹ Flad, “Rethinking the Context,” 117.

¹⁷⁰ Centers for Disease Control and Prevention, 2010, para. 9.

¹⁷¹ Flad, “Evaluating Fish,” Fig. 3; Flad et al., “Radiocarbon Dates,” 167, Fig. 7.

¹⁷² Chen, 151, 156; Flad, “Rethinking the Context,” 113; Flad et al., “Radiocarbon Dates,” 152. Like Yajiao, Wazhadi is a first millennium settlement (Flad et al., “Radiocarbon Dates,” 175).

¹⁷³ Liu & Chen, *State Formation*, 58. The chronology is from Flad, “Divination and Power,” 406.

¹⁷⁴ Liu & Chen, *State Formation*, 64.

¹⁷⁵ Flad, “Rethinking the Context,” 118. This assumed that the briquetage would be used only once. Flad’s first estimate appeared to have made the same assumption.

¹⁷⁶ Flad, “Rethinking the Context,” 113; Flad et al., “Radiocarbon Dates,” 175. There was no mention of any archaeological site underneath the modern county seat of Zhongxian (see Map 5), but Flad stated sweepingly that there were no sizable populations near Zhongba (Flad, “Evaluating Fish,” 242).

¹⁷⁷ As will be explained later, Zhongba producers were also deeply worried about the future during critical changes in manufacturing technique, which implied that they stood to lose heavily from poor production.

¹⁷⁸ Flad, “Evaluating Fish,” 235.

¹⁷⁹ Flad, “Evaluating Fish,” 243-244; Flad, “Rethinking the Context,” 119. The unexplained decline at the end of Phase III (see Flad, “Evaluating Fish,” 244, Fig. 10) could be caused by turmoil associated with the Qin annexation of the Sichuan Basin in 316 B.C.

¹⁸⁰ Flad, “Evaluating Fish,” 244, 249.

¹⁸¹ *Ibid.* 246-247; Flad, “Rethinking the Context,” 119.

¹⁸² Flad, “Rethinking the Context,” 118.

¹⁸³ Flad, “Evaluating Fish,” 242.

¹⁸⁴ *Ibid.* 236.

¹⁸⁵ *Ibid.* 248-249.

¹⁸⁶ *Ibid.* 248.

¹⁸⁷ In Dongxiafeng and Nanguan, for example, Erlitou material culture replaced that of Longshan culture (3000–2000 B.C.) (Liu & Chen, *State Formation*, 69). Erligang replaced Erlitou material culture in all regional centers (*Ibid.* 87).

¹⁸⁸ Liu & Chen, *State Formation*, 108, 119-123.

¹⁸⁹ *Ibid.* 135-141.

¹⁹⁰ Flad, “Rethinking the Context,” 120. It is true that Daxinzhuang also imitated Zhengzhou burial (Li, 15-16). However, Daxinzhuang more than made up for that with its collection of Shang oracle bones (Flad, “Divination and Power,” 413).

¹⁹¹ Flad, “Rethinking the Context,” 112.

¹⁹² Flad, “Divination and Power,” 417.

¹⁹³ Flad, “Rethinking the Context,” 120.

¹⁹⁴ See next paragraph.

¹⁹⁵ Seddon, J. D. (1966). “The Origins of Domestication: Some Developments in the Last Five Years.” *The South African Archaeological Bulletin*, 21(83), 104.

¹⁹⁶ Flad et al., “Radiocarbon Dates,” 152.

¹⁹⁷ Flad, “Rethinking the Context,” 118.

¹⁹⁸ Flad, “Evaluating Fish,” 242.

¹⁹⁹ *Ibid.* 233.

²⁰⁰ Flad, “Rethinking the Context,” 119.

²⁰¹ Redman, 232-233.

²⁰² Flad, “Rethinking the Context,” 119.

²⁰³ *Ibid.* 120.

²⁰⁴ *Ibid.*

²⁰⁵ There was also evidence of animal sacrifices in the production areas (Flad, “Evaluating Fish,” 250).

²⁰⁶ Flad, “Evaluating Fish,” 234, Table 1; Flad, “Rethinking the Context,” 116, Table 7.1.

²⁰⁷ Flad, “Rethinking the Context,” 121.

²⁰⁸ Flad, “Evaluating Fish,” 234, Table 1; Flad, “Rethinking the Context,” 116, Table 7.1.

²⁰⁹ Flad, “Rethinking the Context,” 121.